Published in final edited form as:

Optom Vis Sci. 2009 July ; 86(7): E810–E816. doi:10.1097/OPX.0b013e3181adff59.

Optical Coherence Tomography Reveals Regional Differences in Macular Thickness with Age

Jessica M. Neuville, BS, Kevin Bronson-Castain, PhD, Marcus A. Bearse Jr., PhD, Jason S. Ng, OD, PhD, FAAO, Wendy W. Harrison, OD, MS, Marilyn E. Schneck, PhD, and Anthony J. Adams, OD, PhD, FAAO

School of Optometry, University of California, Berkeley, Berkeley, California

Abstract

Purpose—In order to assist identification of macular thickness abnormalities by optical coherence tomography (OCT), we use techniques that improve spatial localization across the retina to establish any age-related retinal thickness changes in healthy eyes.

Methods—Retinal thickness was measured in 30 eyes of 30 healthy subjects aged 13–69 years. Using Stratus OCT™ 3, twelve radial scans centered at the foveola were acquired and points between scans were interpolated to create a topographic map of the central 20°. The thickness map was divided into 37 hexagonal regions. A mean retinal thickness for each hexagon was computed. Retinal thickness versus age was evaluated for the entire scanned area, 5 anatomical regions, and within individual hexagons. The retinal nerve fiber layer (RNFL) contribution to total retinal thinning was analyzed in the papillomacular region.

Results—There was a small but significant thinning of the overall macular area with increasing age (2.7 $\mu\text{m}/\text{decade}$; $P = 0.027$). Comparing the 10 youngest subjects (age 13–27) to the 10 oldest (age 51–68), retinal thicknesses in the temporal, superior, inferior and foveal regions were not significantly different. However, the two age groups differed significantly in retinal thickness in the nasal region ($P < 0.008$). Across all subjects retinal thickness in this region was linearly correlated with age, decreasing by 4.1 $\mu\text{m}/\text{decade}$ ($P < 0.002$). Approximately 43% of the retinal thinning in the nasal region was attributed to RNFL loss.

Conclusions—The method of OCT acquisition and analysis used in this study allows for greater spatial localization of change in retinal thickness due to age or pathological processes. Based on the results of this study, the macula thins with increasing age, but does so non-uniformly. The greatest amount of thinning occurs nasal to the fovea. RNFL loss accounts for much, but not all of, the thinning in this area.

Keywords

optical coherence tomography; retinal thickness; aging; macula; nerve fiber layer

Over the past several years optical coherence tomography (OCT) has become an important technology for monitoring anatomical changes in the retina due to disease processes such as glaucoma, age-related macular degeneration, and diabetic retinopathy. OCT generates cross-sectional images of the retina from which precise measurements of retinal thickness can be obtained. This enables clinicians to detect and measure subtle changes in macular thickness. However, to be able to distinguish disease processes from normal age-related variation, it is imperative to know whether macular thickness changes with age. Given the potential for local variations in thickness change with disease and age, there is also a need for more age-referenced local measures of normal retinal thickness.

Studies on retinal thickness in relation to age have reported conflicting results. Two studies have reported no relationship between age and retinal thickness.^{1,2} In another study that looked specifically at foveal thickness, no relationship with age was found.³ However, there have been some reports of changes in retinal thickness with age. Kanai et al.⁴ measured retinal thickness at the foveola and at four points one millimeter outside of the foveola and found retinal thinning with age at all points except the foveola. Alamouti and Funk⁵ found that the retina thins with age at the temporal edge of the optic nerve.

Our study aims to resolve some of the discrepancies in the literature. In the present study, normal macular thickness was measured in healthy eyes to determine if average thickness varies among cohorts at different decades of life. Conventional OCT analysis of macular thickness uses six radial scans centered on the foveola. In this study, twelve radial scans were obtained per eye to generate thickness measurements at twice as many retinal points. Based on these scans a novel method of OCT analysis that divides the scanned retina into 37 areas was used to produce greater spatial localization of retinal thickness. Such increased spatial localization is likely to be important in retinal conditions such as diabetic retinopathy. Using these methods, the macula (central 20°) was found to thin non-uniformly with increasing age.

METHODS

Thirty eyes of 30 healthy subjects (14 males, 16 females) were included in the study. Subjects ranged in age from 13 to 69 years, with 5 subjects per decade. The range and average age of the subjects per decade are listed in Table 1. Subjects were considered for inclusion in the study if they had best-corrected visual acuity of 20/20 or better, refractive error between +3.00 and -5.00 D, and no existing or prior history of ocular pathology. Patients were dilated with 1% tropicamide and 2.5% phenylephrine before OCT scanning was performed. The study protocol was approved by the University of California committee for the protection of human subjects and written informed consent was obtained from all participants.

Retinal thickness was measured using the Stratus OCT™ 3 (Carl Zeiss Meditec, Inc., Dublin, CA). Subjects were asked to fixate a central target while 12 radial cross-sectional images of the retina were acquired sequentially. Each 6-mm scan was composed of 512 axial scans (9–10 µm axial resolution and 11 µm longitudinal resolution) centered on the foveola. Acquisition time was 1–2 seconds per scan. If subjects lost fixation during a particular scan

or if it was contaminated by a blink, the scan was rejected and re-acquired. The average scan signal strength was 7.9 with a standard deviation of 1.5. The Stratus software delineates the vitreoretinal interface and the pigment epithelial/photoreceptor outer-segment interface, and then measures the difference between the two at each axial scan location.⁶ This provides 512 thickness measurements per scan.

Retinal thickness measurements for each scan were exported for further processing in Matlab. (MATLAB®, MathWorks™, Inc, Natick, Mass.) One eye of each subject was chosen randomly for inclusion in the analysis. A continuous 360-degree topographic thickness map of the central 20° (diameter) of the retina was created by interpolating the points between each scan using triangle-based linear interpolation and fitting this to a 1024×1024 grid. All eyes were converted to left eye orientation. Figure 1A shows the OCT scans overlaid on a pseudo-color retinal thickness map.

The thickness map was then divided into 37 hexagonal areas that were scaled with eccentricity and range in size from 0.26 – 0.88 mm². Figure 1B shows the hexagonal pattern overlaid on a fundus photograph. (The geometry of these 37 areas was chosen because it maps onto the stimulus array of the multifocal electroretinogram. In other studies, we are examining the relationships between local retinal function and retinal thickness in diabetes. The scaling of the hexagons approximates retinal cone density.) In order to correct for the ambiguous assignment of thickness measurements falling on a hexagonal boundary, a uniform exclusion zone of 6 samples wide was created at each hexagonal border. The number of thickness measurements (A-scans) falling within a given hexagon ranged from 63 at the smallest peripheral location to 707 at the center location. The total number of points within a hexagon, including interpolated points, ranged from 5,020 to 17,637. An average retinal thickness for each hexagon was computed from the total number of points falling within the given area. This allowed for the analysis of retinal thickness in relatively small, discrete areas. For each of the hexagonal areas the relationship between age and retinal thickness was examined.

We also grouped the hexagons into retinal regions in order to reduce the effect of multiple comparisons (Figure 1C). The superior (hexagons 2, 3, 6, 7, 8), nasal (hexagons 10,16,17, 23), temporal (hexagons 15, 21, 22, 28), and inferior (hexagons 30, 31, 32, 35, 36) regions as well as the central foveal (2.5°) region (hexagon 19) were compared across subjects and between the 10 youngest and 10 oldest subjects. Linear regression was used to examine the relationship between retinal thickness and age. Critical P-values were adjusted for multiple comparisons.

We also examined the contribution of the retinal nerve fiber layer (RNFL) to the total retinal thickness at 6 discrete locations 1.7–2.3 mm nasal to the foveola along the horizontal scan (Figure 1D) using the nerve fiber layer analysis and the retinal thickness analysis of the Stratus OCT™ 3. The region measured was limited to this nasal area due to the thinness of the RNFL temporal to the foveola and the resolution limitations of the Stratus OCT™. The RNFL and total retinal thicknesses were then separately averaged across these 6 samples for each subject. The relationships between the two mean measures and age were then analyzed using linear regression.

RESULTS

A total of 30 eyes of 30 healthy subjects ranging from 13 to 69 years of age were examined. Macular thickness was systematically evaluated beginning with the overall mean macular thickness, followed by the examination of the four anatomical regions and the fovea, and then within individual hexagonal areas. Lastly, we analyzed the RNFL contribution to the retinal thinning in the papillomacular region.

Mean Macular Thickness

In order to compare mean macular thickness across subjects, the retinal thickness was averaged across the 37 hexagonal areas for each subject. Figure 2 shows that across all subjects, there is a small but significant decrease in overall macular thickness with age ($-2.7 \mu\text{m}/\text{decade}$; $R^2 = 0.16$, $P = 0.027$). To estimate the loss over a 50-year span we used the regression equation from Figure 2 to calculate the mean macular thickness for hypothetical subjects 15 and 65 years of age. The result of these calculations show that a 15 year old would have an average macular thickness of $254.0 \mu\text{m}$ and a 65 year old would have an average macular thickness of $240.5 \mu\text{m}$. This corresponds to a 5.3% ($13.5\mu\text{m}/254\mu\text{m}$) thinning of the macula over a 50-year span. Figure 3 shows pseudo-color maps of retinal thickness for the 5 youngest (13–19) and 5 oldest (61–69) subjects. Note that the greatest retinal thickness (dark red) occurs in the younger group, and is most noticeable in the nasal hemifield (on the left in each map).

Regional Analysis

To determine if the rate of change in retinal thickness varies depending on macular location, the scanned area was divided into the 5 macular regions shown in Figure 1C. The slope of the linear regression line for each region, except the fovea, is negative, indicating a trend toward retinal thinning with increasing age. Table 2 shows the R^2 and P values for each of the 5 regions. The greatest thinning with age is seen in the nasal region, decreasing by $4.1 \mu\text{m}/\text{decade}$ ($R^2 = 0.31$; $P < 0.01$; Figure 4A). This corresponds to a 7.6% thinning in the nasal region over a 50-year span. No other region showed a statistically significant correlation between retinal thickness and age (Figures 4B–E).

To determine whether the youngest and oldest subjects differed in retinal thickness, t-tests were performed on the 5 regions (Table 3). Comparing the 10 youngest subjects (age 13–27) to the 10 oldest subjects (age 51–68), retinal thicknesses are again not significantly different in the temporal, superior, inferior and foveal regions. However, the two age groups do differ significantly in retinal thickness in the nasal region ($P = 0.01$). This is consistent with the linear relationship described earlier.

Individual Hexagonal Areas

Retinal thickness at each of the 37 hexagonal areas was compared across all subjects to increase the spatial localization of our measurements. Regression plots were generated for each location. Figure 5 shows two examples of regression plots for single hexagonal locations. The results of linear regression show a trend toward thinning with age at each hexagonal location, except the central foveal hexagon. The greatest thinning with age is seen

in the nasal hexagons (hexagons 16, 23, 24, 29 $P < 0.01$; hexagons 5, 10, 17, 30, 34, 35 $P < 0.05$; Refer to Figure 1B for the location of the hexagons). However, these trends for local retinal thinning are not statistically significant after adjusting critical P-values to 0.0014 ($0.05/37 = 0.0014$) to account for the 37 statistical tests.

Retinal Nerve Fiber Layer

Given that the nasal region shows the greatest thinning with increasing age, the RNFL in this region was examined to determine its contribution to the total retinal thinning as shown in Figure 1D. Linear regression for RNFL thickness shows a statistically significant ($P < 0.01$) slope of $-1.8 \mu\text{m/decade}$ (Figure 6A), while total retinal thickness decreases by $4.1 \mu\text{m/decade}$ ($P < 0.01$; Figure 6B). To estimate the loss over a 50-year span we used the regression equations from Figure 6A to calculate retinal and RNFL thickness at 15 and 65 years of age. A 15 year old would have an average RNFL thickness of $36.0 \mu\text{m}$ and a 65 year old would have an average RNFL thickness of $27.2 \mu\text{m}$ in this nasal area. The $8.8 \mu\text{m}$ decrease represents a 24.4% loss of the RNFL over 50 years in this nasal region. For total retinal thickness in this region, a 15 year old would have an average retinal thickness of $278.4 \mu\text{m}$ and a 65 year old would have an average RNFL thickness of $258.0 \mu\text{m}$. This $20.4 \mu\text{m}$ decrease represents a 7.3% loss over 50 years in this nasal region. This result is very close to the 7.6% loss estimated from the regional analysis method described earlier. These results suggest that RNFL thinning accounts for approximately 43% of the total retinal thinning ($8.8 \mu\text{m}$ RNFL thinning/ $20.4 \mu\text{m}$ total retinal thinning) in this region.

DISCUSSION

OCT measurements of macular thickness are accurate and reproducible.^{7,8,9} Because of this, OCT can be used to diagnose subtle retinal pathology. To better accomplish this goal, it is essential that normative values be established, and that any healthy age-related differences be accounted for. Our study aimed to determine how macular thickness differs between cohorts of different ages by measuring both the overall mean macular thickness and smaller localized areas.

The first clear conclusion of our study is that the macula thins with increasing age outside of the foveal region. This result agrees with Kanai et al.⁴ who also found that macular thickness decreases with age. In contrast, there have been reports that there is no change in macular thickness with age. In the Göbel et al. study¹, the Humphrey model 2000, an older version of the OCT, was used to measure retinal thickness with three horizontal scans and one vertical scan through the fovea. Zou et al.² measured retinal thickness in a sample of Chinese subjects, ages 21 to 50, with the retinal thickness analyzer. The older instrumentation¹ and smaller subject age range² in these two studies might help explain differences in their results from those of our study. However, it should be noted that, consistent with previous studies, we found no significant correlation between thickness and age in the local foveal region.^{3,4}

A second conclusion is that retinal thinning is not uniform across the macula. We found the greatest age-related thinning nasal to the fovea. The rate of change in this area is $-4.1 \mu\text{m/decade}$ compared to $-2.7 \mu\text{m/decade}$ for the entire scanned area. There are several factors

such as RNFL thinning, change in vessel caliber, and loss of retinal cells, that might account for the difference seen in this region.

A third conclusion from this study is that, in the nasal region, the RNFL loss contributes considerably to the overall retinal thinning. At the nasal locations analyzed in the current study we found that the RNFL thickness decreased with increasing age by approximately 1.8 $\mu\text{m}/\text{decade}$. This accounted for 43% of the total retinal thinning in the nasal region. It has been reported that humans lose as many as 7000 retinal nerve axons per year, causing the thickness of the RNFL to decrease.^{10,11,12} Two recent OCT studies found that mean peripapillary RNFL thickness decreases by 1.6–2 $\mu\text{m}/\text{decade}$.^{11,13} The inability to demonstrate any significant retinal thinning in our study in the temporal, inferior, and superior regions might only reflect the fact that these areas can be expected to have a thinner RNFL, being further from the optic nerve.

The additional retinal thinning, not accounted for by loss of the RNFL, could be due to decreases in vessel caliber and/or loss of cells. Several studies have found that increasing age is associated with smaller retinal vessel diameter.^{14,15,16} Klein et al.¹⁶ found that in a control group of subjects, arteriolar caliber decreased by 1.0 m/decade and venular caliber decreased by 0.7 m/decade . Retinal cell number has also been reported to decrease with age.^{17,18,19,20} Harman et al.¹⁷ found a decrease in neuron number in the retinal ganglion cell layer with increasing age; they estimated that in the macular region, neuronal density decreased by 0.29% per year. Curcio et al.¹⁸ estimated that rod density decreased in the central 28.5° by about 30% over almost 60 years. Gao and Hollyfield¹⁹ also found a decrease in rods, as well as cone photoreceptors and retinal pigment epithelial cells, from the second to ninth decade. However, these decreases were not evident in the fovea, where photoreceptor and RPE cell density remained stable with age; the lack of thinning in the foveal region, in our study, is consistent with this latter finding. Bipolar cells may also be involved in retinal thinning. Aggarwal et al.²⁰ found that after the third decade, rod bipolar cell density starts to decrease. From our analysis we cannot ascertain the source of the retinal thinning not accounted for by loss of RNFL; however, it is likely due to a combination of decreases in vessel caliber and loss of retinal ganglion, photoreceptor, bipolar, and RPE cells.

A final key point we wish to emphasize is that the methods of OCT acquisition and analysis used in this study are unique and differ from those used in previous reports. They allow greater separation of retinal locations in the analysis of thickness, using technology currently available. Obviously, newer generations of OCT offer promise for even greater separation of retinal locations and greater resolution of thickness measures even within layers of the retina. In addition, our methods make it possible to map mfERG results directly onto OCT retinal thickness measurements to compare retinal function to anatomical changes in pathological processes such as diabetic retinopathy. These methods can also be used with new spectral-domain OCT devices, which provide greater resolution capabilities compared to the Stratus OCTTM, a temporal-domain instrument.

A potential limitation of this study is the small sample size. Whereas the overall macular thickness decreased with increasing age, the only subregion to demonstrate significant

thinning was in the nasal area. Although larger subject sample sizes might reveal statistically significant thinning in additional macular regions (or, perhaps, foveal thickening), the important point is that the nasal region thinned with increasing age at a greater rate than the other macular areas.

In conclusion, using optical coherence tomography, we show that among healthy individuals the retina thins non-uniformly with age in the central 20°. Although the amount of thinning found in our study is small, it could be clinically important in evaluating OCT measurements, especially in the nasal region of the retina. For example, a retinal thickness of 270 µm in the nasal region might be normal for a 30-year-old patient but could indicate retinal thickening due to edema in a 70-year-old patient. The current version of Stratus OCT™ adjusts for age in RNFL analysis at the optic nerve; however, it does not adjust for age in macular thickness measurements. Based upon the results of this study, normative databases for future versions of the OCT and other retinal imaging instruments should consider the effect of age on overall macular thickness and any regional differences.

Acknowledgments

The authors thank Lernik Mesropian for her assistance in data analysis.

This research was supported by the following grants: NEI T35 EY007139-13, NEI R01 EY02271, and Prevent Blindness America 0612.

Part of this study was presented as a poster at the 2008 annual conference of the Association for Research in Vision and Ophthalmology (ARVO), Fort Lauderdale, Florida.

References

1. Göbel W, Hartmann F, Haigis W. Determination of retinal thickness in relation to the age and axial length using optical coherence tomography. *Ophthalmologe*. 2001; 98:157–62. [PubMed: 11263041]
2. Zou H, Zhang X, Xu X, Yu S. Quantitative in vivo retinal thickness measurement in chinese healthy subjects with retinal thickness analyzer. *Invest Ophthalmol Vis Sci*. 2006; 47:341–7. [PubMed: 16384983]
3. Chan A, Duker JS, Ko TH, Fujimoto JG, Schuman JS. Normal macular thickness measurements in healthy eyes using Stratus optical coherence tomography. *Arch Ophthalmol*. 2006; 124:193–8. [PubMed: 16476888]
4. Kanai K, Abe T, Murayama K, Yoneya S. Retinal thickness and changes with age. *Nippon Ganka Gakkai Zasshi*. 2002; 106:162–5. [PubMed: 11925953]
5. Alamouti B, Funk J. Retinal thickness decreases with age: an OCT study. *Br J Ophthalmol*. 2003; 87:899–901. [PubMed: 12812895]
6. Costa RA, Skaf M, Melo LA Jr, Calucci D, Cardillo JA, Castro JC, Huang D, Wojtkowski M. Retinal assessment using optical coherence tomography. *Prog Retin Eye Res*. 2006; 25:325–53. [PubMed: 16716639]
7. Muscat S, Parks S, Kemp E, Keating D. Repeatability and reproducibility of macular thickness measurements with the Humphrey OCT system. *Invest Ophthalmol Vis Sci*. 2002; 43:490–5. [PubMed: 11818395]
8. Carpineto P, Ciancaglini M, Zuppari E, Falconio G, Doronzo E, Mastropasqua L. Reliability of nerve fiber layer thickness measurements using optical coherence tomography in normal and glaucomatous eyes. *Ophthalmology*. 2003; 110:190–5. [PubMed: 12511365]

9. Tangelder GJ, Van der Heijde RG, Polak BC, Ringens PJ. Precision and reliability of retinal thickness measurements in foveal and extrafoveal areas of healthy and diabetic eyes. *Invest Ophthalmol Vis Sci*. 2008; 49:2627–34. [PubMed: 18515592]
10. Dolman CL, McCormick AQ, Drance SM. Aging of the optic nerve. *Arch Ophthalmol*. 1980; 98:2053–8. [PubMed: 7436843]
11. Parikh RS, Parikh SR, Sekhar GC, Prabakaran S, Babu JG, Thomas R. Normal age-related decay of retinal nerve fiber layer thickness. *Ophthalmology*. 2007; 114:921–6. [PubMed: 17467529]
12. Balazsi AG, Rootman J, Drance SM, Schulzer M, Douglas GR. The effect of age on the nerve fiber population of the human optic nerve. *Am J Ophthalmol*. 1984; 97:760–6. [PubMed: 6731540]
13. Budenz DL, Anderson DR, Varma R, Schuman J, Cantor L, Savell J, Greenfield DS, Patella VM, Quigley HA, Tielsch J. Determinants of normal retinal nerve fiber layer thickness measured by Stratus OCT. *Ophthalmology*. 2007; 114:1046–52. [PubMed: 17210181]
14. Sun C, Liew G, Wang JJ, Mitchell P, Saw SM, Aung T, Tai ES, Wong TY. Retinal vascular caliber, blood pressure, and cardiovascular risk factors in an Asian population: the Singapore Malay Eye Study. *Invest Ophthalmol Vis Sci*. 2008; 49:1784–90. [PubMed: 18436813]
15. Klein R, Klein BE, Knudtson MD, Wong TY, Tsai MY. Are inflammatory factors related to retinal vessel caliber? The Beaver Dam Eye Study. *Arch Ophthalmol*. 2006; 124:87–94. [PubMed: 16401789]
16. Klein R, Klein BE, Moss SE, Wong TY, Sharrett AR. Retinal vascular caliber in persons with type 2 diabetes: the Wisconsin Epidemiological Study of Diabetic Retinopathy: XX. *Ophthalmology*. 2006; 113:1488–98. [PubMed: 16828517]
17. Harman A, Abrahams B, Moore S, Hoskins R. Neuronal density in the human retinal ganglion cell layer from 16–77 years. *Anat Rec*. 2000; 260:124–31. [PubMed: 10993949]
18. Curcio CA, Millican CL, Allen KA, Kalina RE. Aging of the human photoreceptor mosaic: evidence for selective vulnerability of rods in central retina. *Invest Ophthalmol Vis Sci*. 1993; 34:3278–96. [PubMed: 8225863]
19. Gao H, Hollyfield JG. Aging of the human retina. Differential loss of neurons and retinal pigment epithelial cells. *Invest Ophthalmol Vis Sci*. 1992; 33:1–17. [PubMed: 1730530]
20. Aggarwal P, Nag TC, Wadhwa S. Age-related decrease in rod bipolar cell density of the human retina: an immunohistochemical study. *J Biosci*. 2007; 32:293–8. [PubMed: 17435321]

Figure 1.

(A) OCT scans (dark radial lines) superimposed on a topographic pseudo-color map of retinal thickness. (B) Scanned area of the macula (6 mm diameter) divided into 37 hexagonal areas. (C) Hexagonal pattern divided into 5 retinal regions (nasal, inferior, temporal, superior and fovea). (D) OCT scan showing the area of the macula nasal to the foveola where 6 discrete RNFL and total retinal thickness measurements were obtained (1.7–2.3 mm from the foveola).

Figure 2.

Plot of overall macular thickness versus age. Retinal thickness decreases by 2.7 μm/decade of age.

Figure 3. Topographic pseudo-color maps of retinal thickness plotted as left eyes. **Left:** average of the 5 youngest subjects with a mean age of 16.6 years. **Right:** average of the 5 oldest subjects with a mean age of 65.2 years.

Figure 4.

Plots of retinal thickness versus age for the 5 retinal regions. Only the nasal region showed a significant thinning with age (4.1 μm/decade; $P < 0.01$).

Figure 5.

Examples of plots of retinal thickness versus age for two single hexagonal areas. All hexagonal areas outside of the center hexagon showed a trend toward thinning with increasing age.

Figure 6.

Plots of (A) total retinal thickness and (B) nerve fiber layer thickness averaged from 6 points 1.7–2.3 mm nasal to the foveola. Both show significant thinning with increasing age.

Table 1

Study population demographics.

Age Group	Range (years)	Mean±SD	Male:Female
1	13.8 – 19.3	16.6±2.5	2:3
2	20.2 – 27.3	24.8±2.9	3:2
3	30.6 – 36.9	33.4±3.0	2:3
4	42.4 – 49.7	46.1±3.3	2:3
5	51.2 – 58.8	55.5±3.0	3:2
6	61.0 – 68.9	65.2±2.8	2:3

Table 2

Regression analysis of retinal thickness versus age by region.

Region	R ²	P-value	m/decade
Nasal	0.31 *	<0.01 *	-4.1 *
Inferior	0.12	0.06	-3.0
Temporal	0.07	0.15	-2.1
Superior	0.10	0.08	-2.5
Fovea	0.01	0.70	1.1

* Statistically Significant

Table 3

Comparisons of the 10 youngest and 10 oldest subjects.

Region	Youngest (mean±SD)	Oldest (mean±SD)	P-value
Nasal	226±15	217±11	<0.01 *
Inferior	253±17	242±14	0.13
Temporal	259±16	249±7	0.13
Superior	268±13	253±8	0.10
Fovea	169±28	177±30	0.55

* Statistically Significant